Edible films and coatings in postharvest handling

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- Waxing as a postharvest operation
- Edible films
- Rationale for using edible films
- Effects of edible coatings
- Film components and characteristics
- Film additives
- Coatings for the future

The term ‘coating’ - refers to thin layer of wax, oil, or other material applied to the surface of the fruit as an addition to or replacement for the natural protective waxy coating

Waxing is used:

- to reduce water loss
- to replace natural waxes removed during washing
- to cover injuries
- to act as carriers for fungicides
- to improve fruit's cosmetic appearance

Application of waxing materials by dip application

By submerging the commodity into a tank of emmulsion.

The produce is washed, dried, then immersed in the dip tank.

Complete wetting is important.

Then the commodity is conveyed to a dried to remove water or allow to dry

Spray application

High-pressure spray applicators used with good coverage

Foam application

A foaming agent is added to the coating. The agitating foam is then dropped onto the commodity as it moves over the rollers

Brushes distribute the emulsion over the commodity

Edible film and coatings in postharvest handling

History

12th-13th centuries coatings of oranges and lemons with wax to retard desiccation

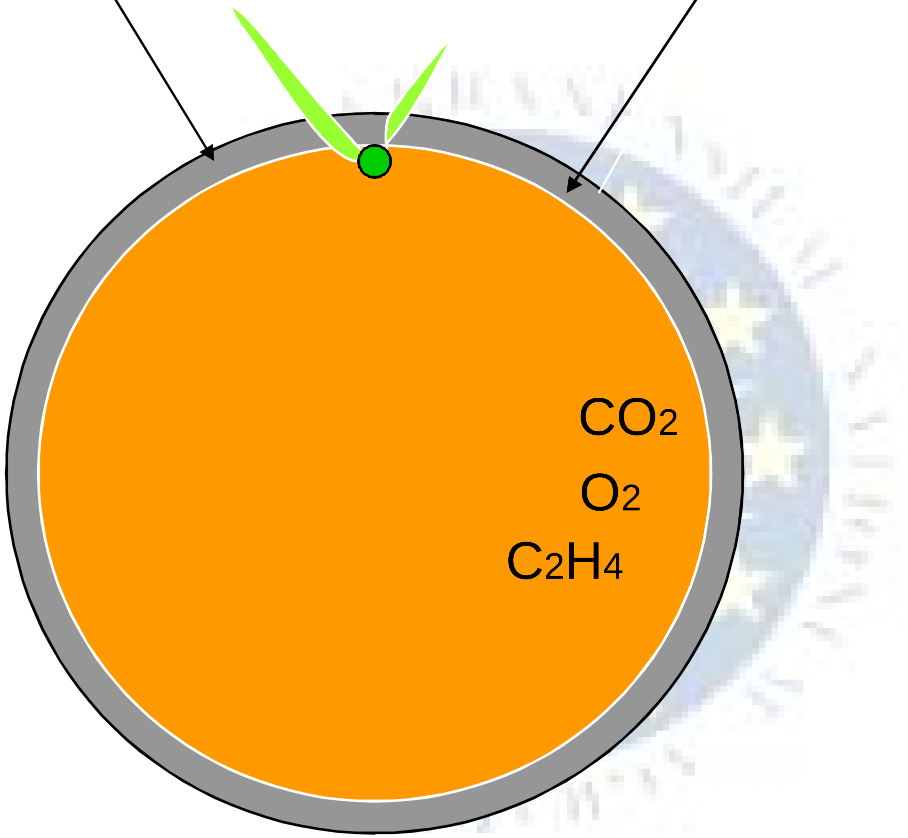
1930 carnaouba wax used in U.S.A. for coating fruits and vegetables

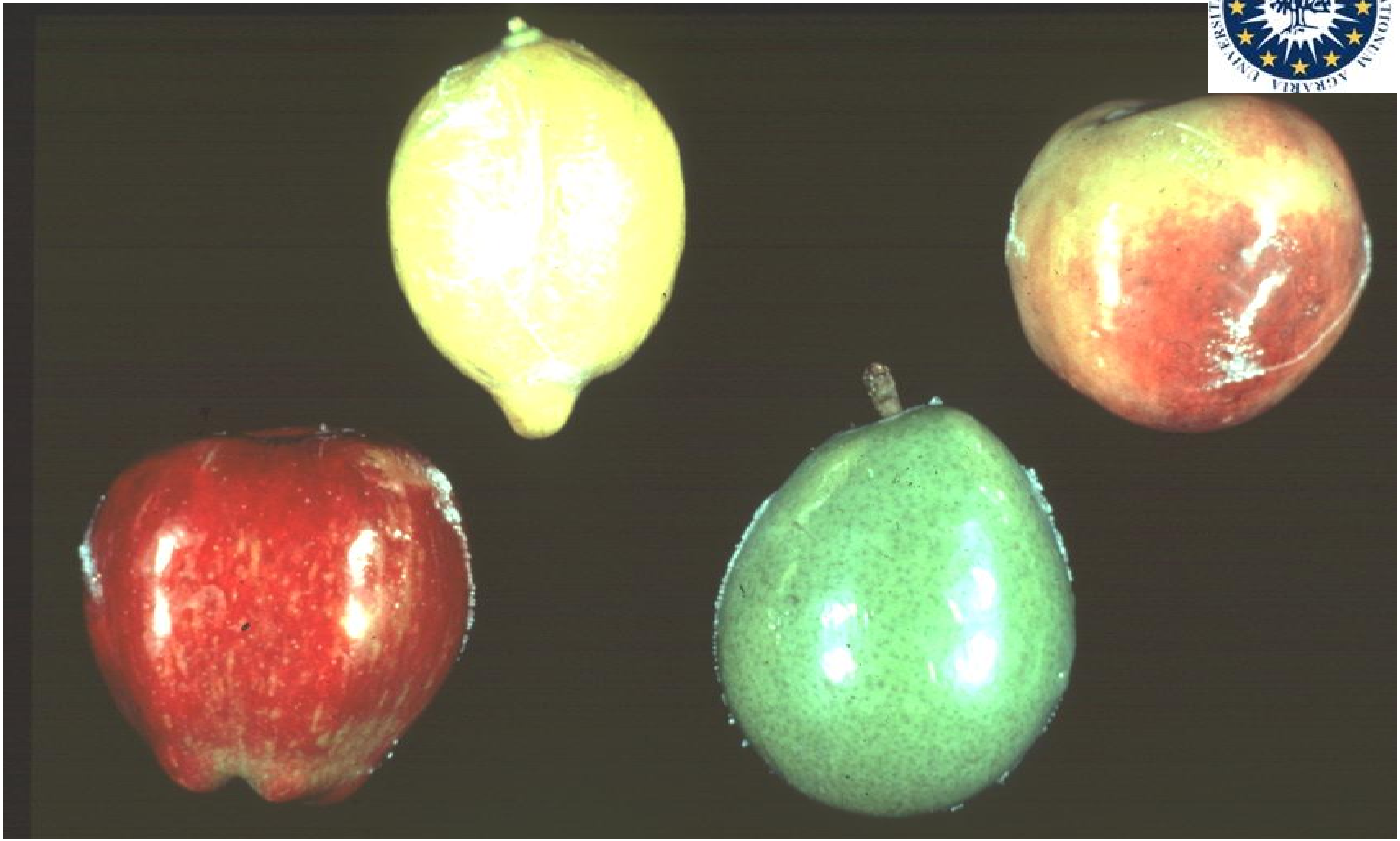
1980 many edible coatings were used to reduce mositure loss, control scald and reduce surface abrasion

Edible coatings

- polysacharides
- proteins
- lipids
- resins

+ antimigrobials
fungicides





Effects of coatings:

on fruit quality (on texture and color changes, chlorophyll degradation) related to the degree of atmosphere modification, cultivar, storage temperature)

physiological disorders the insidence of which depends on atmospheric concentration (core-flush, flesh browning and breakdown), accumulation of ethenol and alcoholic off-flavors, scald and bitter pit

weight loss with hydrophobic coatings-wax coatings have marked reduction in weight loss,with hydrophilic coatings-sucrose ester-based coatings no effect

diffusion barrier direct effects on the internal concentration O2 and CO2

ethylene action

Rational for using edible films

(improving overall quality, extending shelf life)

Possible functional properties of coatings:

resistance to moisture migration

critical levels of water activity must be maintained for optimum quality, stability and safety

direct economical impact since fruits are sold on a weight basis

To reduce water loss

a) enrobing the produce with an edible film with good moisture-barrier properties and

b) by reducing the storage temperature

retards gas transport reduces respiration like CA storage control of O2 and CO2 markedly influences storage stability (oxidation of lipids, viatmins, flavor compounds or pigments)

improves mechanical-handling properties reduce injury to the epidermal cells during handling

retains volatile flavor compounds direct

carriers food additives

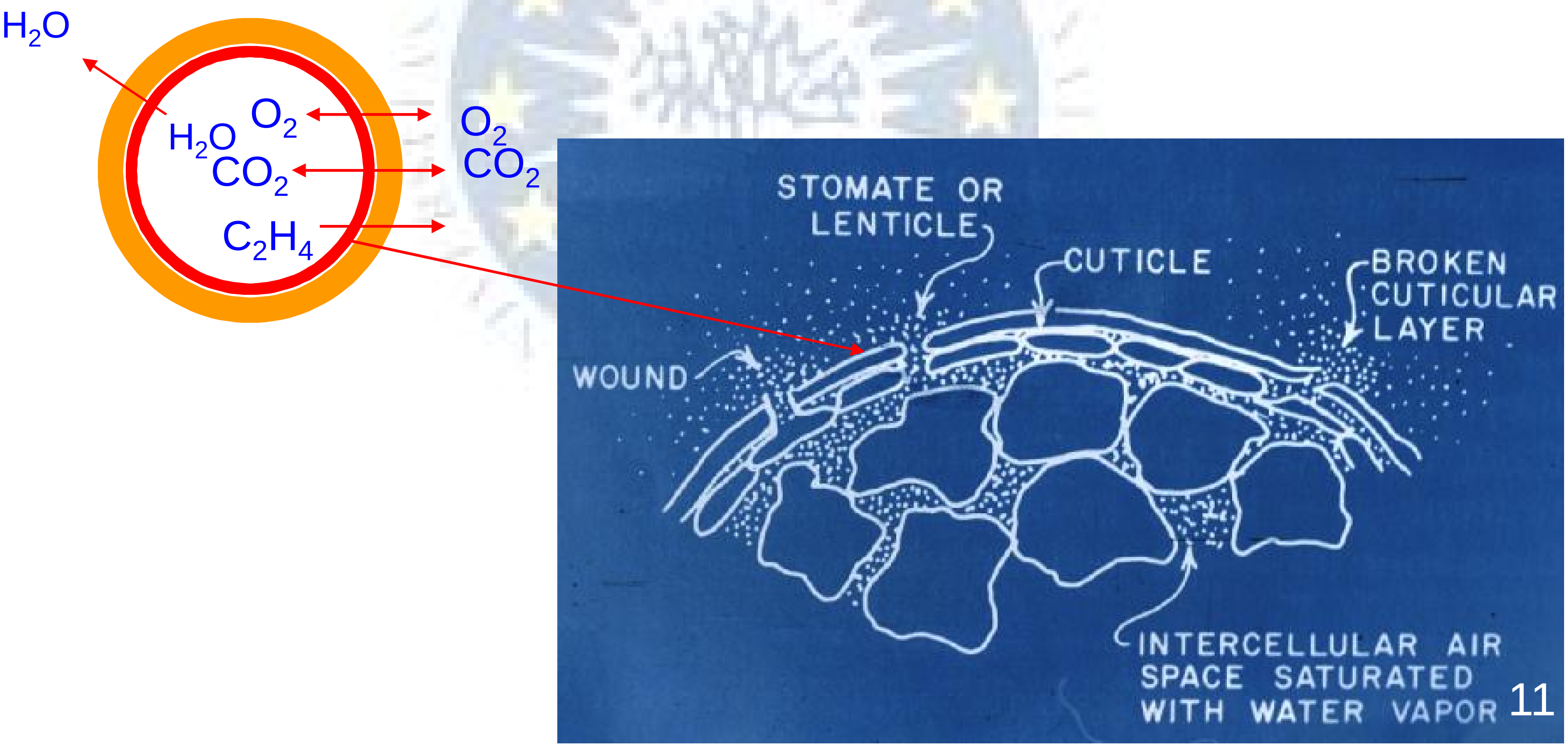
(antimicrobial agents, antioxidants into specific locations)

Effects of coatings

On weight loss

([Oil-based] coating marked reduction in weigh loss.

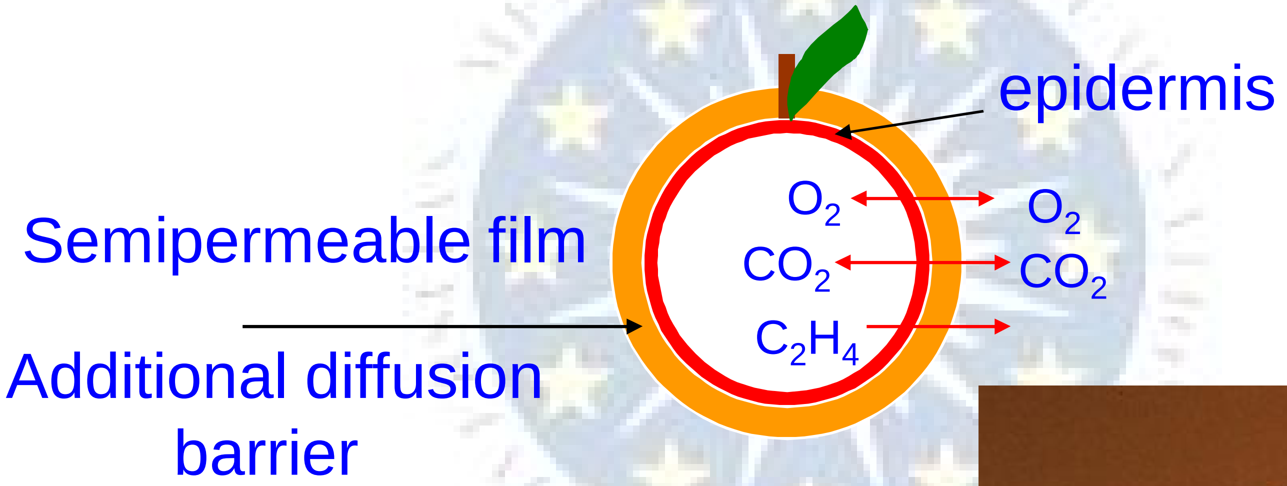
Sucrose ester slight reduction in weight loss)

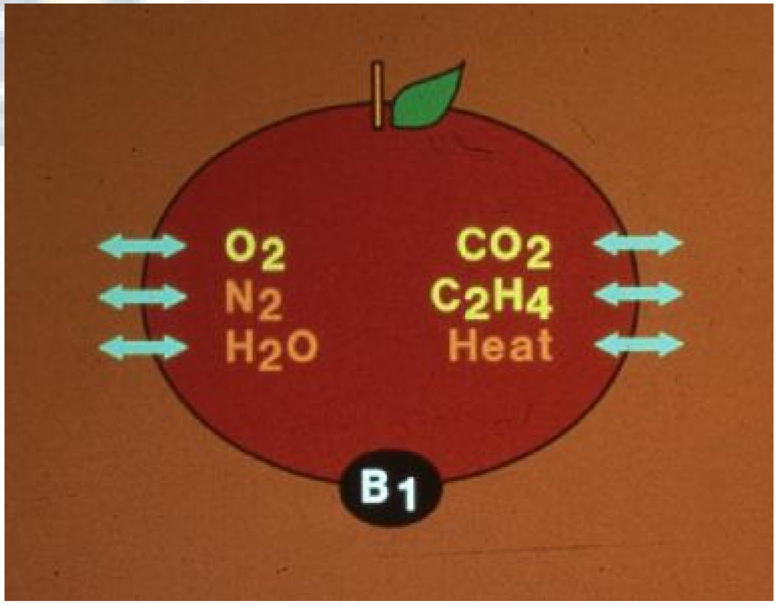


Effects of coatings

Discussion barrier effects on product-generated atmospheres

(CO_2, O_2 & C_2H_4)

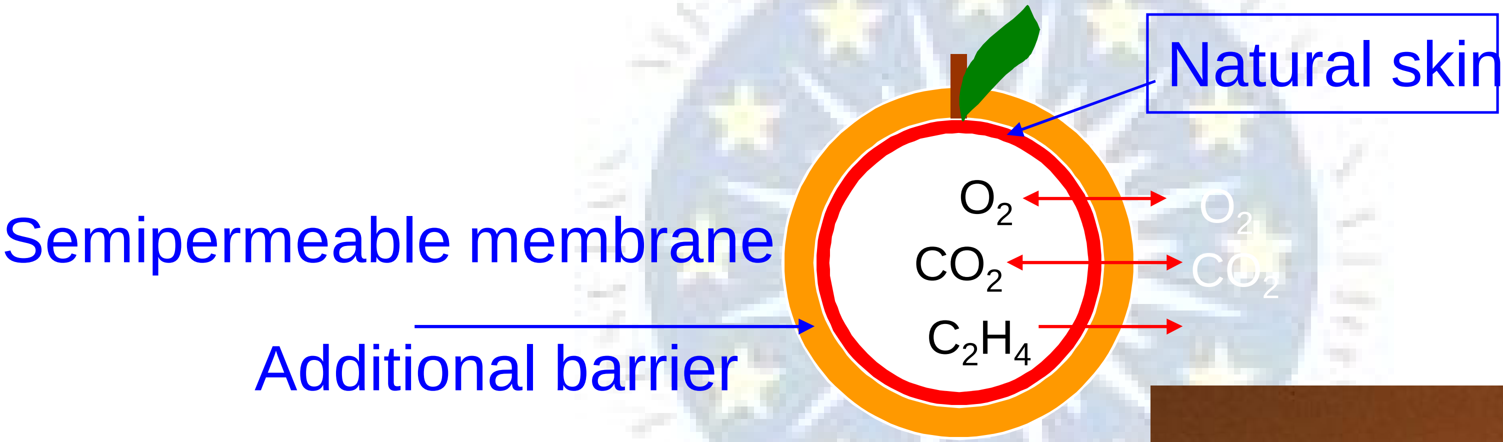


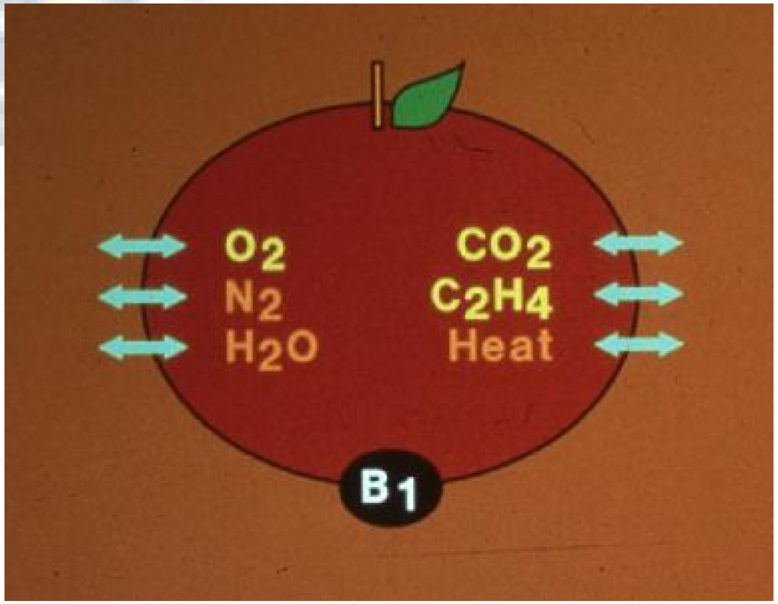


Edible coatings

Modification of the internal atmospher

(CO_2, O_2 και C_2H_4)





Internal atmosphere modificationin relation to coating concentration for four apple cultivars

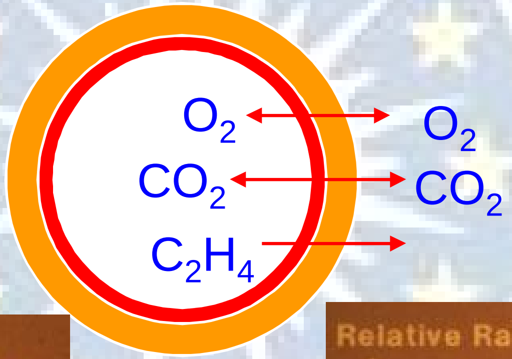
Cultivar	Internal Atmosphere component	Percent composition: Polysaccharide composition (%) w/v 0	1	1.5	2
Cox's Orange Pippin	O2	16.6	8.4	7.7	6.6
	CO2	1.5	5.4	5.8	7.4
Bramley	O2	17.1	14.6	12.4	10.5
	CO2	0.4	2.7	3.4	2.9
Spartan	O2	16.3	10.8	9.5	8.5
	CO2	1.7	3	3	2.1
Golden Delicious	O2	17.3	12.9	9.5	6.3
	CO2	1.1	3.5	3.5	2.5

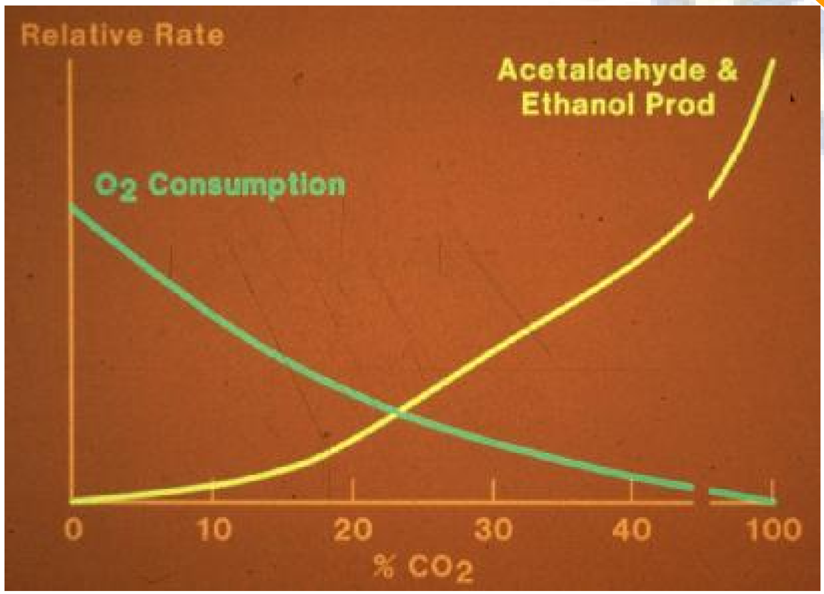
Source: Smith et al. 1987

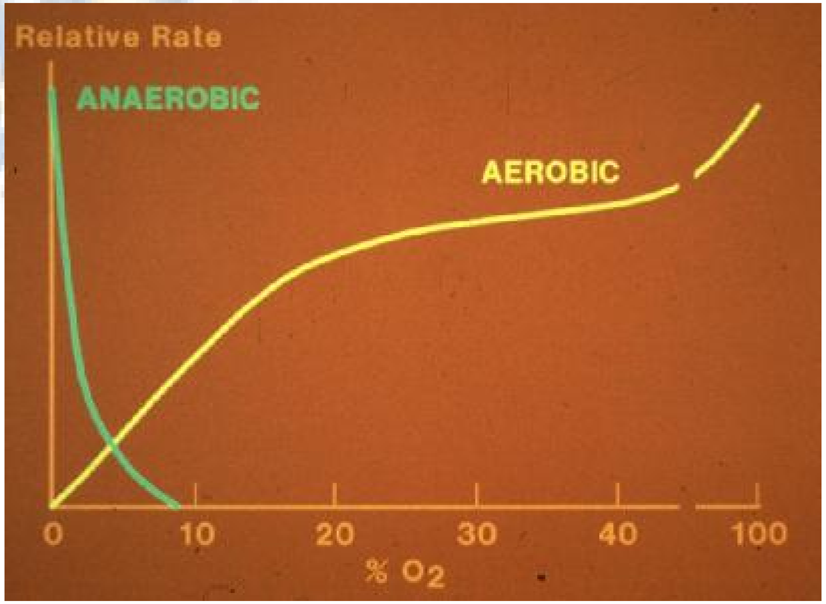
Effects of coatings

On physiological disorders
(accumulation of acetaldehyd and ethanol

(apples-core flash, flesh browning and breakdown, scald and bitter pit)







Advantages of coatings/MAP

Minor problem with moisture condensation-since fruit surface temperature and coating temperature are the same

Problems:

Variability in response of fruit to similar coating

Fruit to fruit variation in coatings/ MAP

The fruit cannot be reliably removed following transfer to a different environment (e.g. temperature)

Coating may therefore place undesirable constrains upon the way fruit can subsequently be handled

Best to study method and material experimentally
Develop edible coatings
Measure permeability characteristics----------------->
Diffusion studies
Prediction of internal O_2 and CO_2 concentrations
Metabolic changes of fruits under the coating

Film components:

Hydrocolloids

proteins
cellulose derivatives
alginates
pectins
starches
polysacharides

Lipids

waxes
acylglycerols
fatty acids

Composites

lipids
hydrocolloids

Two layers

Hydrocolloids

proteins
cellulose derivatives
alginates
pectins
starches
polysacharides

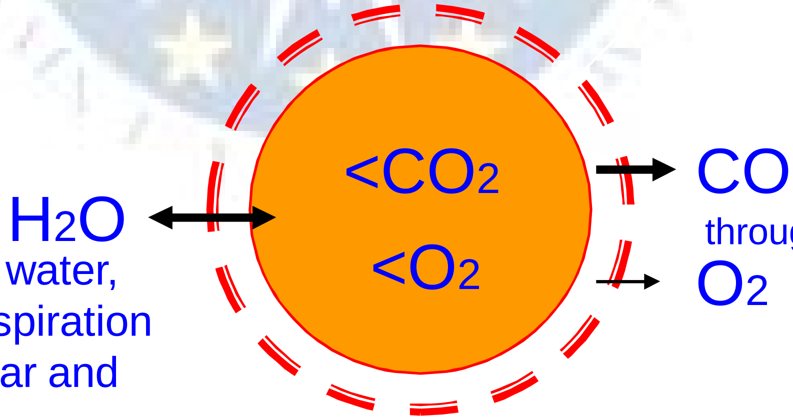
Can be used in applications where control of water vapor migration is not the objective
Good barriers to O_2 and CO_2,
have desirable mechanical properties

Polysaccharide coatings

Due to hydrophilic nature provide only minimal moisture barriers
Mimic CA or MA storage
The CO_2 and O_2 permeability of the polysaccharide-based coatings result in retardation of fipening in many climacteric fruits, increasing shelf-life, without creating severe anaerobic conditions
TAL Pro-long made up of sucrose polyester of fatty acids and sodium salt of carboxymethyl cellulos.
Applied as dip, drench or spray.

Semperfresh similar composition to TAL prolong

Semperfresh a thin film of H_2O



CO_2 (dissolves and difusses through water 20X faster than O2)

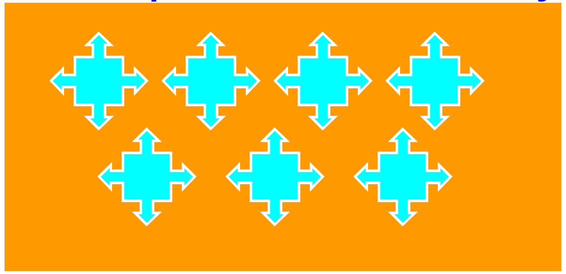
Semperfresh not good barriers to water, but have some effect on fruit transpiration due to stomatal blockage, lenticular and stem scar opening

Lipids

waxes
acylglycerols
fatty acids

Used as berriers to water vapor
to retard respiration

FA and fatty alcohols are effective berriers to water vapor if they are used in conjunction with supporting matrix
Many lipids exist in a crystalline form and their individual crystals are highly impervious to gases and water vapor.
The permeate can pass between crystals,



Wax and oil coatings

Wax preparations on citrus, apples.mature green tomatoes, rutabagas and cucumebers

They are made with natural or synthetic waxes and fatty acids (carnauba, polyethylene, oleic acid), oils (vegetable and mineral oil), wood rosin, shellac, and coumarone indene resin, emulsifiers, anti-foam agets, surfactans and preservatives.

Most companies claim that their coatings reduce water loss, add various degrees of shenn and provide adequate permeability to CO_2 and O_2.

Shellac waxes coat better, dry faster and produce a higher shine.

Composites

lipids
hydrocolloids
Combine the advantages of lipid and hydrocolloid components and lessen the disadvantages of each
Heterogeneous films of hydrophobic particles within a hydrophilic matrix
Nature-Seal   Cellulose derivatives as film formers (chitosan+ lauric acid)

Lipid-hydrocolloid bilayers

Multicomponent edible film

Bilayer film containing a blend of stearic and palmitic acids and carnauba wax as one layer and either gelatin or casein as the other

lipid-hydrocolloid bilayers

A layer of stearic and palmitic acids

A layer of hydroxypropyl cellulose

Multicomponent edible film

Bilayer film containing a blend of stearic and palmitic acids and carnauba wax as one layer and either gelatin or casein as the other

Film additives

the functional, organoleptic, nutritional and mechanical properties of the edible films can be improved by addition of various chemicals in minor amounts

Additives in Fruits and vegetables

potential benefit of additives:

growth regulators (auxins, gibberelic acid) polyamines
to delay ripening and senescence and color changes

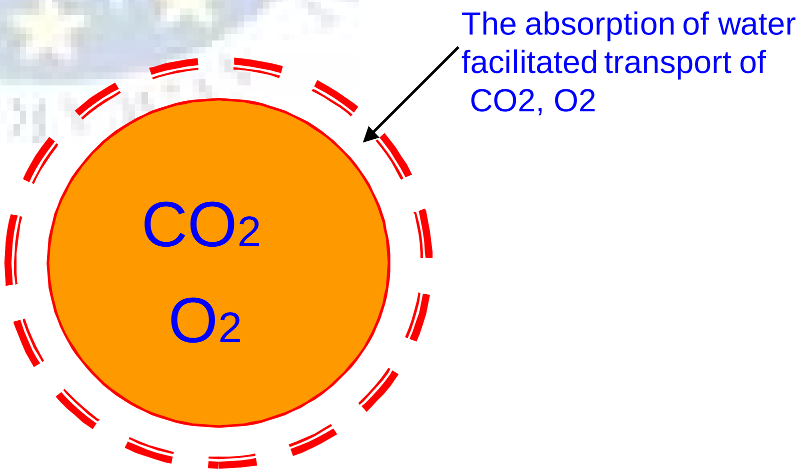
incorporating biological control agents (yeast, bacteria, fungi) to reduce postharvest diseases

Coatings for the future

Chitosan [(1.4)-linked 2 amino-2-deoxy-β-D-glucan]

derivative of Chitin (crutacea) also in cell wall of fungi
Chitosan induced chitinase in palnt tissues, a defense enzyme that degrates fungal cell walls, and elicited the phytoalexin pisatin in pea pods

Nutri-Save --> simulated CA/MA in apples and pears, reduced rates of respiration and water loss
With methilation of chitosan Nutri-Save -> 2X increase in the resistance of CO_2
1-2% solution + surfactant provided a ligh sheen
Εξάτμιση νερού 0,8 mg H2O/cm^2/ώρα



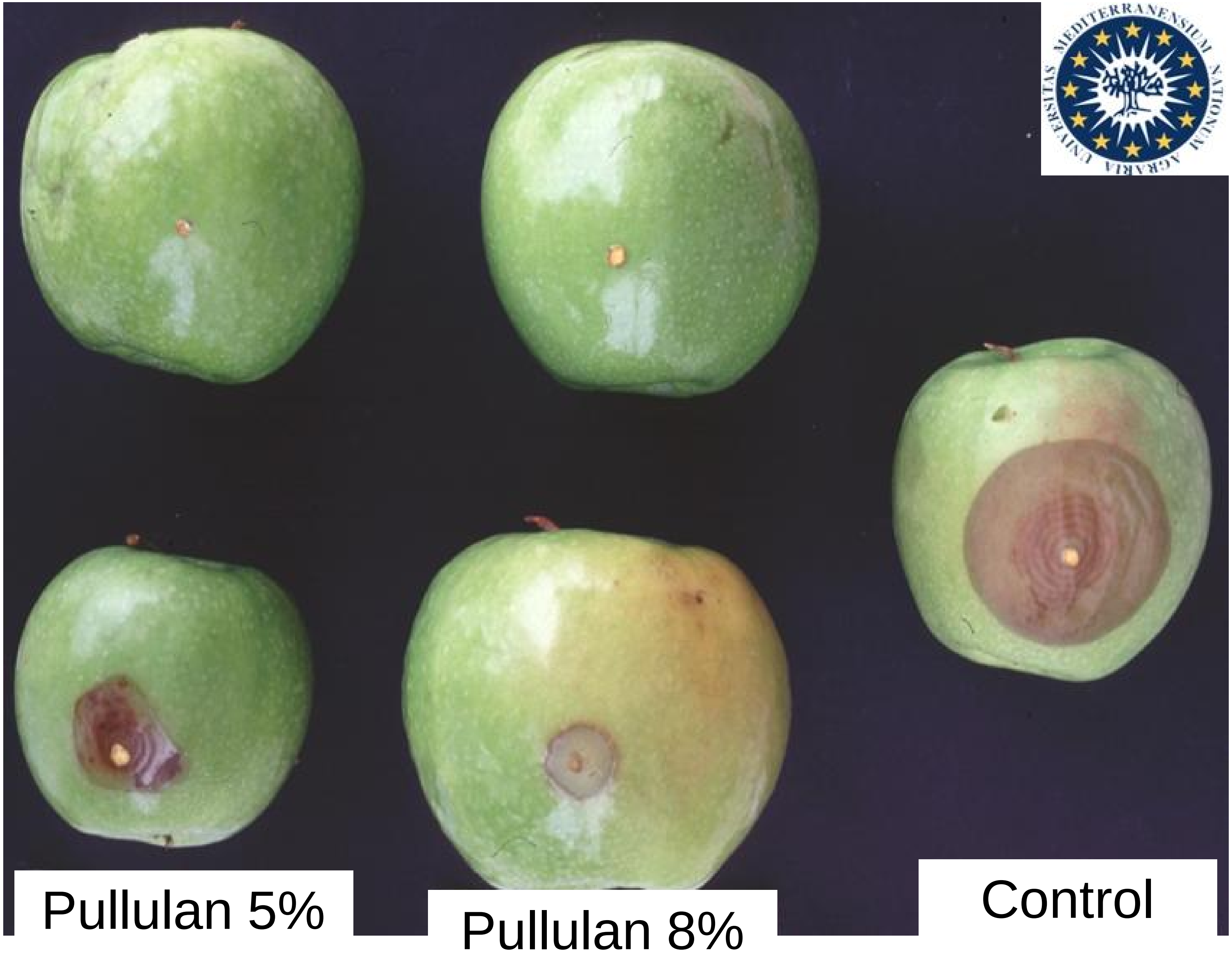
Chitosan 0.3% Chitosan 0.5% Control

Coatings for the future

Pullulan ?

Produced from *Aureobasidium pullulans*
induced enzymes β-1,3-glucanase, chitinase andperoxidase


FIRST HARVEST – 14.10.2000
VACUM
PULLULAN
SPERMIDINE
CONTROL 1 – COLD WATER
CHITOSAN
PUTRESCINE


Pullulan 5%
Pullulan 8%
Control

Resin 1% Resin 0.5% Control

Mastic resinous gum and mastic oil from *Pistacia lentiscus* var. Chia

Hellenic and Roman world

Hippocrates -Ulsers -therapeutic properies of mastic

Homer mentioned in Iliad the use of mastic

Physisians-Dioscorides wroten on De Materia Medica mastic gum medical substance

Discovered mastic by Columbus vited February 15, 1493 the island of Chios the home of mastic production

Prevents the development of plaque on the gums

Known for anti-cancer properties

Extract from the leaves of mastic tree
antibacteria and antifungall activity-reduce
bacterial colonies of *Staphylococcus aureus*,
Escherichia coliant, the fungus Candida albicans
Mastic resins have antioxidant activity

Study in Athens
(http://var/homepagees/mastic/)
by GC/MS 70 contsituents 3
with antibacterial activity


Control
Wax + mastic